THE CARDON MANAGEMENT GROUP
1841 EASTON AVENUE, BETHLEHEM, PA 18017

COPY

Hill Rivkins & Hayden LLP
45 Broadway, Suite 1500
New York NY 10006-3739

July 1, 2004

SUBJECT: Boom Hoist - Motor Vessel Leon I

Dear Sirs:

On October 8, 2003, at the request of Hill Rivkins & Hayden, I traveled to Annapolis, Maryland USA for the purpose of examining of a length of wire rope stored there. I had been retained to provide an opinion based upon my personal examination. It was my understanding that I would be examining a wire rope that had failed during service as the boom hoist line on a fixed shipboard crane mounted on the Leon I during an accident that had occurred on July 29, 2000.

My qualifications for making wire rope observations of this kind, including a list of my publications, are shown in Attachment A. The purpose of my visit was to make observations about the condition of the wire rope based on detailed visual examination. In this report, my use of the correct and accepted industry terminology has been implemented, containing the following defined words:

- wire = the individual elements from which a wire rope is manufactured.
- strands = elements comprised of wires placed in specific spatial relationship around a core by rotating machinery.
- core = the central part of a wire rope (usually comprised of another smaller rope, either fiber or metal) which supports the strands.
- wire rope = the flexible, load-bearing combination of strands with a core.

[Note: I have inserted this glossary because in the field there is a tendency to use the word "strand" to mean a single wire, and to use the word "wire" to mean a wire rope.]

All the visual observations I made on the wire rope were conducted in accord with established industry examination procedures described in reference documents such as the *Wire Rope Users Manual*, and also contained in various Federal OSHA documents (e.g. *Mobile Crane Inspection Guidelines for OSHA Compliance Officers – June '94)* that have been derived from information such as that provided in the *Wire Rope Users Manual*, which is currently published and distributed by the Wire Rope Technical Board, Alexandria, Virginia.

Upon arrival at the storage facility, I was taken to a room where several pallets loaded with coils of six-strand wire rope were stacked against a wall. The storage area was relatively clean and dry, implying that there had been little, if any, additional deterioration during several years of storage. No conventional wire rope handling equipment was available. As the wire rope was approximately one inch in diameter, a

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size that is usually manipulated easily by hand, I requested permission to uncoil all of it outdoors on a nearby paved street so as to be able to examine the entire length closely in bright sunlight.

During the unraveling process, I began to recognize specific attributes of the wire rope. It was immediately apparent to me, when the point of failure had been unraveled, that the wire rope I was examining was a six strand wire rope containing a fiber core. The two ends at the point of failure were easily located due to their distinctive appearance. After the wire rope had been arranged in the sunlight on the paved street, into a semblance of its original relationship, I next attempted to examine the entire length of it as minutely as possible, using a magnifying glass on occasion. At several places, other than the point of failure I also removed exterior lubricant to be able to better assess the condition of the wires.

During this process I was assisted by others who measured the diameter of the rope at my request and measured the lengthwise distance from the terminal fitting at the point where I was making observations and taking notes. By measuring the diameter, in several directions, we were able to verify that the wire rope had retained its roundness and was not flattened. Measuring the lengthwise distance to the point of failure made it possible to calculate the location of failure on a reeving diagram.

In ordinary service, all wire ropes will begin to exhibit obvious signs of progressive deterioration from any one of three primary causes: *corrosion*, *abrasive wear*, or *fatigue* of individual wires, or from a combination of two or all three of these kinds of progressive deterioration, all of which are detectible by visual examination. These visible indicators are reliable. They have been established after more than a century of practice, and they are universally applied.

During my examination of the entire length I noted that the wire rope was in relatively good condition. Other than at the point of failure, the wire rope had very few broken exterior wires, little wear on the crowns of the exterior wires, and did not display recognizable evidence of corrosion.

My focus of attention next was drawn to the apparent point of failure where the wire rope had parted, causing the accident. This portion of the wire rope exhibited two distinctive appearances:

[a] the strands appeared to have parted in a sequence; first a single strand, then two more together, and lastly the remaining three together.

[b] broken wires in the parted strands showed a mixture of necked-down or cup-and-cone type breaks, together with breaks that were more squared, and the strands were somewhat spiraled or curled probably due to some form of severe mechanical deformation at the time of, or instantly prior to, the failure.

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This kind of failure is representative of a well-known and unfortunately common kind of wire rope abuse, sometimes known as the "jumped sheave condition", although it can also be caused by other similar forms of service abuse involving small radius bending, any of which will result in a tension failure of the wire rope at a load level dangerously below the rated load.

Conclusions

[1] The wire rope I examined October 8, 2003 was for the most part in relatively good condition, and was lubricated properly. Based upon my review of the documents and testimony of the case, and considering that the wire rope had been laid out for inspection by a qualified person prior to installation, followed by the verification proof load test, and given the fact that a destructive tensile test performed on a sample of the wire rope December 21, 2000 showed that the wire rope had ample strength, I was able to conclude the failure of the wire rope most probably was *not* the result of any kind of recognizable progressive deterioration in ordinary service prior to the accident, and that the accident was *not* likely to have been caused by any of the conventional factors, including gross physical damage, that are ordinarily detectable during any routine visual examination by a qualified person.

[2] The wire rope I examined October 8, 2003 appeared to have suffered catastrophic failure caused by extreme tension overload while being subjected to abnormal bending conditions such as those created when the wire rope is no longer adequately supported by the groove of a sheave. It was my understanding that the operating crew were, at the time of the accident, deliberately using the crane in an extreme configuration with the safety limit controls deactivated. Although I did not actually examine the crane itself, I have certain knowledge, derived from 48 years experience in the wire rope industry, that exactly this kind of unsafe operating malpractice can lead to conditions that will cause a sudden and unexpected failure of any wire rope, even a new and unused wire rope. The post-accident appearance of the failed wire rope supports this conclusion.

Respectfully submitted,

Donald Sayenga, President
The Cardon Management Group

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ATTACHMENT A

Donald Sayenga Vitae:

Employment
Independent Management & Technical Consultant since 1988
Paulsen Wire Rope Corporation 1986-1988
Bethlehem Steel Corporation 1956-1985
[General Manager - Wire Rope Division 1982-1985]

Education
Bachelor of Science in Metallurgical Engineering, Lafayette College, 1956
Advanced courses at: Lehigh University, Harvard Business School, Wharton School

Wire Rope Industry-related Positions
48 years experience in the wire rope, wire, and wire products industry
Current - Technical Adviser, Asso. Wire Rope Fabricators, Walled Lake MI -since '89
Current - Member ASME B30 - safety standards for cranes, derricks, etc. -since '89
Current - Member Ferrous Mgt. Committee - The Wire Association - Guilford CT
Current - Member Technical Advisory Group ANSI-ISO TC 105 Wire Rope Standards
1988-2004 - Chief Executive - Associated Wire Rope Fabricators - Walled Lake MI
1999-2001 - President - Intl. Org. for Study of Wire Rope Endurance - Paris, France
1985 - Chairman - Wire Rope Committee - American Iron & Steel Inst. - Wash. DC
1981 - Co-Chairman - Committee of Domestic Wire Rope Producers - Wash. DC

Contact and Information:
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Voice Phone: 610-691-8708
Fax - 520-886-0695
E-Mail - *Dsayenga@aol.com*
Fee Basis Employment = $600 per day.
Travel expenses to be reimbursed at cost.
Traveling by automobile - rate is 36-1/2 cents per mile.

Other Cases in which Testimony has been given in the last 4 years:
None

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ATTACHMENT B

My Publications on the subject of wire rope in the last 10 years:

OIPEEC = French acronym for International Organization for the Study of Wire Rope Endurance

1. OIPEEC Proceedings - 1993 Conference at Delft, Netherlands
"The First Applications of High-Tensile Steel Wire Ropes for Civil Engineering"

2. OIPEEC Bulletin No. 69 - 1995
"Wedge Socket Attachments"
(I developed this paper jointly with Francis Hardy, Construction Safety Association of Ontario, but by agreement he has published also his own work separately under his own name)

3. OIPEEC Proceedings - 1997 Conference at Reading, UK
"John Roebling's Initial Studies of Wire Rope Endurance and the Creation of 3-Size"

4. OIPEEC Proceedings - 2001 Conference at Bethlehem PA USA
"The Great Britain Splice" co-authored with
Roland Verreet, Aachen, Germany and
Dr. Isabel Ridge, University of Reading, UK

5. OIPEEC Proceedings - 2003 Conference at Lenzburg, Switzerland
"The Advent of Wire Rope Constructions - Four Case Studies"

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Hill Rivkins & Hayden LLP
45 Broadway, Suite 1500
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August 5, 2004

SUBJECT: Boom Hoist - Motor Vessel Leon I

Dear Sirs.

In my report dated July 1, 2004, I stated that the wire rope I examined at Annapolis MD on October 8, 2003 showed obvious signs of a "tension failure of the wire rope at a load level dangerously below the rated load". I said the accident was most probably caused by "small radius bending" of the wire rope which is "representative of a well-known and unfortunately common kind of wire rope abuse". Also, I emphasized that "the post-accident appearance of the failed wire rope supports this conclusion". I wish to draw attention to several digital photographs made on October 8, 2003 at the time of my investigation:

Photograph Marked DSC00285

This photograph illustrates the post-accident condition of one end of the broken wire rope at the point of failure, displaying the severe corkscrew-like distortion of the wire rope. The appearance of this kind of extreme mechanical damage is ample demonstration that the wire rope was trapped and forced to bend while under tension over a very small radius at this point.

Photograph Marked DSC00289

This photograph illustrates the post-accident condition of the other end of the broken wire rope at the point of failure illustrating that one strand failed first under tension in the region of severe mechanical distortion leading to sequential and immediate failure of the other strands at points where there is no similar distortion illustrative of small radius bending.

Photograph Marked DSC00286

This photograph of the wire rope in post-accident condition at the point of failure shows the location, evidenced by the taped cut ends, which appears to be the place where a sample length was removed during an earlier investigation. It is obvious there is no severe mechanical deformation caused by small radius bending in the region immediately adjacent to the point of failure.

This kind of tension failure can be caused by any one of several forms of service abuse involving small radius bending. Also, I have observed the same appearance of the wire rope in a photograph marked **EC002665 (#47)** that was contained in the exhibits accompanying the Coast Guard's accident investigation report. This appearance of the post-accident wire rope condition can be seen quite clearly. I would have pointed this out to the Coast Guard investigators had I been present at that time.

Respectfully,

Donald Savenga

Savenga 4
EXHIBIT NO.
DATE 8-31-04
REPTR SDF
L.A.D. REPORTING